The cocoon spinning behaviour and fecundity of *Stegodyphus sarasinorum* Karsch (Araneae: Eresidae) from India[1]

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(With seven text-figures)

Observations on the sequence of cocoon spinning behaviour and fecundity of the social spider *Stegodyphus sarasinorum* Karsch (Eresidae) are given.

Introduction

In the genus *Stegodyphus*, cocoons have been observed by Marshall (1898), Jambunathan (1905), Millot & Bourgin (1942), Phanuel (1960) and Bradoo (1972a), but the mechanism of cocoon spinning in *Stegodyphus* has not been investigated before. The cocoon spinning behaviour among spiders affords a good example of a succession of instinctive responses controlled by both internal and external stimuli. The spinning activity is so organised that no stage can be omitted and no stage repeated. The different stages of this behaviour follow one after the other as in a chain automatic behaviour.

This paper, describes the sequence of cocoon spinning behaviour and fecundity of the social spider *S. sarasinorum* Karsch, common in Kerala, south India.

Methods of study

The cocoon spinning behaviour of *S. sarasinorum* Karsch, was studied in seven batches that were established in the laboratory. Each batch

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contained 5 to 10 gravid females placed within a loosely closed glass jar. After a few days of nest construction inside the jar, the females make their cocoon on the nest surface or on the web around the nest. As the cocoon spinning is a nocturnal activity in this spider, a dim torch light was used during the course of these observations.

The complete sequence of cocoon spinning behaviour was observed only seven times in the laboratory and the duration for each stage in the sequence, was recorded. The later stages of this sequence were also observed in several field colonies of this species that were regularly examined during the breeding season.

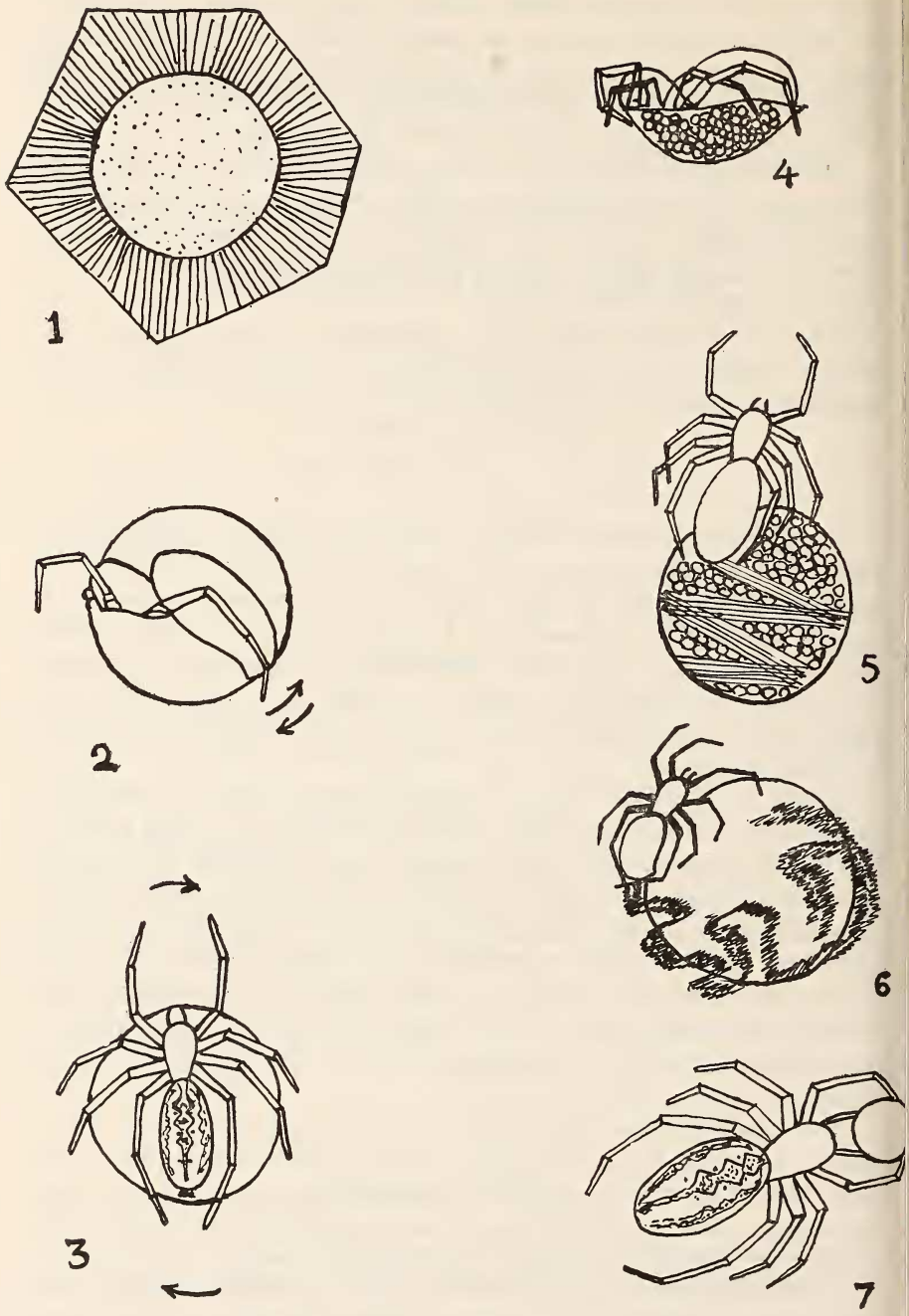
For studying the fecundity of *S. sarasinorum* Karsch, a total of 41 cocoons collected from different localities in Calicut (Kerala), were examined for egg count in the laboratory.

Cocoon spinning behaviour

S. sarasinorum Karsch, has an annual life history (Jambunathan 1905). The breeding season of this spider starts from the middle of January and continues till early April, but the maximum number of cocoons are made in the month of February. Marshall (1898) reports that the egg-laying season of a South African *Stegodyphus* sp. starts in the month of February or March and Millot & Bourgin (1942) report that the solitary species, *S. lineatus* lays eggs in the month of June, in southern Europe.

Behaviour of gravid females. The gravid females of *S. sarasinorum* are larger in size and they move more slowly than the normal females. The gravid females bear well developed and functional silk glands (Bradoo & Majupuria 1973), but they do not take an active part in snare construction. They feed on prey, captured mostly by other members of the colony. During the breeding season, gravid females construct several brood chambers lined with soft cribellar silk for storing their cocoons, within the tunnels of their nest. This makes the nest architecture suitable for the breeding purpose and for the new generation of spiders that hatch from the cocoons.

The gravid females also spend most of their time in 'toilet movements', grooming the dorsal surface of the abdomen with hind legs, upper side of the cephalothorax with anterior legs and they groom their appendages with one another. Such toilet movements are more commonly performed by the mature and the gravid females of the colony. The gravid females also take part in colony foundation, as they leave their nest, individually or in groups of few individuals and then they establish new breeding nests, close to the parent nest (Bradoo 1972b). Each gravid female makes a total of 2 to 4 cocoons during the breeding season.



The Cocoon spinning behaviour of *S. sarasinorum* Karsch.
Fig. 1. Platform with the central disc; Figs. 2 and 3. Construction of the receiving valve; Fig. 4. Oviposition; Fig. 5. Concealing the egg-mass; Fig. 6. Spinning of Cribellar silk around the cocoon; Fig. 7. Transportation of the cocoon.

In *S. sarasinorum,* the cocoon spinning behaviour normally involves ten stages in the following sequence:

1. *Construction of the Platform*: The first step in cocoon spinning behaviour is the construction of a loose silken platform (Fig. 1) consisting of numerous closely arranged silk threads, placed side by side, close to the nest surface. The spinning of the platform is finished within about 9 to 15 minutes. The finished platform appears as an oblique or horizontal thin sheet of smooth supporting silk, on the upper middle surface of which the cocoon is spun.

The construction of the platform starts normally after midnight, when the other members of the colony are busy, either spinning cribellar silk on the web or feeding on some ensnared prey. The spinning of the platform indicates the start of the cocoon spinning behaviour and if the spider is disturbed at this stage, she at once retreats into her nest and never returns back to resume the work on the platform. The cocoon spinning is also suspended, as and when the spider receives strong web-signals from other members of the colony, rushing to their nest due to some disturbance in the surroundings. Undisturbed and calm surrounding is hence essential for the successful completion of the platform. After the platform is ready, the spider examines it by palpal contacts and quickly shakes her abdomen sidewise and this releases the next phase of the spinning behaviour i.e. the construction of the receiving valve.

2. *The Receiving Valve*: The receiving valve is made by rubbing the mid and hind spinnerets over the upper middle surface of the platform. During this process, the spider taps (dabs) her abdomen up and down, adding silk over the platform and at the same time, she changes her orientation, turning clockwise or anticlockwise. Such dabbing movements continues for a short time till the platform shows a thin smooth pinkish-white circular disc (Fig. 1), that later becomes the cup-like receiving valve of the cocoon. After the formation of this disc, the spider then thickens only the margin of the disc by making two types of spinning movements on the upper side of the disc. These movements include, (i) a short sidewise movement of the abdomen, resulting in the repeated brushing of the spinnerets along the margin of the disc. This results in the gradual thickening of the periphery of the disc that becomes the receiving valve (Fig. 2). (ii) The second type of movement involves the rotation of the spider (clockwise or anticlockwise) over the same upper side of the receiving valve. This results in a uniform thickening of the margin of the receiving valve so that a shallow depression is gradually formed in its middle (Fig. 3).

The above mentioned two spinning movements continue simultaneously, as the spinnerets add silk over the receiving valve. During this spinning activity, the spider receives tactile stimuli through the palps,

that are constantly kept in contact with the margin of the valve and it is accompanied by a slight arching of the abdomen. The palpal contact is necessary for the continuity of the spinning movements. A single rotation of the spider over the valve is completed in an average of one and a half minutes and such rotations continue for about 25 to 40 minutes, after which the construction of the receiving valve is complete. The receiving valve is supported by the platform.

3. *Rest*: The completion of the receiving valve is always followed by about 4 to 5 minutes rest. During this period, the spider remains motionless over the receiving valve without making any visible movements. This duration may be necessary for the eggs to move down from the ovaries into the basal part of the oviducts for deposition.

4. *Oviposition*: The rest stage is followed by certain characteristic movements of the cephalothorax and up and down movement of the abdomen, accompanied by quick shivering of the legs. The spider remains flat and then adjusts her epigynal furrow over the receiving valve and within 2 or 3 minutes, she starts depositing her eggs. During this process, the spider again remains motionless, the anterior pair of legs remain deflexed beneath the cephalothorax. Some fluid is also secreted along with the eggs that keeps them glued into a single yellowish egg-mass as also reported in *S. lineatus* by Millot & Bourgin (1942). The completion of oviposition is followed by the next stage, provided the spider is not disturbed at this stage.

In some field colonies of *S. sarasinorum,* sometimes after oviposition, the spider suspends her further spinning activity due to some external disturbances and leaves her incomplete cocoon so that the egg-mass finally shrivels.

5. *Concealing the Egg-mass*: The eggs deposited within the receiving valve are immediately covered by loose thin silk threads taken out quickly from the spinnerets. In this process, the spider moves her abdomen sidewise, brushing her spinnerets very quickly over the surface of the egg-mass (Fig. 5) which is concealed in about 4 to 7 minutes. With each stroke of the abdomen, the spinnerets produce many straight silk threads extending from one to the other margin of the valve (Fig. 5). This phase is then followed by spinning of the covering valve.

6. *The Covering Valve*: The spinning of the covering valve is brought about by the repeated brushing of the spinnerets all over the concealed egg-mass, in a haphazard manner. The spider always changes her direction during this spinning activity. The spinning movements of this phase are exactly similar to those made at the start of the formation of the receiving valve. The covering valve is completed in about 40 to 50 minutes, after which it appears as a thin whitish papery cover over the eggs.

After the completion of the covering valve, the smooth double convex white cocoon is looked after by the mother. Even if disturbed, she

does not leave her cocoon now, but firmly holds it with her palps and legs. My observations revealed that it is mainly the size and the tactile stimuli from the cocoon surface that she responds to, as an empty cocoon from another nest of its kind would also be accepted by the mother, and looked after like her own cocoon. The gravid females, that have not oviposited, do not show maternal care, although they may accept cocoons temporarily.

These observations show that the maternal care in *Stegodyphus* starts shortly after the oviposition and completion of the covering valve of the cocoon and that this behaviour shown by the mother is instinctive, released probably by both internal and external stimuli. The internal stimulus probably comes from the brain while the external stimulus involves mainly the tactile stimuli received from the cocoon surface. That the central nervous system of spiders contain certain neurosecretory cells, has recently been reported by Legendre (1954a, 1954b, 1958) and Sasira Babu (1965).

With the completion of the covering valve of the cocoon, the spider continues the next phase of her behaviour.

7. *Removal of some supporting threads*: The completion of the covering valve is followed by the removal of a few supporting silk threads present around the cocoon. The mother slowly cuts only a few of these silk threads of the platform by the help of her chelicerae within 2 to 5 minutes and this results in a slight tilt in the original flat position of the cocoon. The cocoon becomes slightly free along one side. This is followed by the next phase, the spinning of the cribellar silk.

8. *Cribellar silk*: For the first time in cocoon spinning behaviour, the spider starts spinning sticky cribellar silk over the cocoon surface and along the margin (Fig. 6). This provides a firm attachment between the two valves of the cocoon. The spinning of cribellar silk is a slow process for which both the hind legs are used by the spider and this stage lasts for about 35 to 49 minutes. Like *Stegodyphus,* other cribellates also cover their cocoons with cribellar silk and this has certain advantages. Norgaard (1941) reports that the cocoons of *Eresus niger* Pet. are covered with cribellar silk and many foreign bodies like sand grains, remains of prey and plant matter are also added to camouflage the cocoon. Bradoo (1972b) found a *Uloborus* spider covering her baglike cocoon with cribellar silk, that is useful to a great extent for preventing the ovipositional activity of its egg parasite. In *S. sarasinorum* the cribellar silk not only unites the two valves of the cocoon but it also provides a rough surface for convenient transportation by the mother. The adhesive cribellar silk also protects the cocoon from ants that sometimes raid the nests of social spiders (Bradoo 1972a).

9. *Separation of the Cocoon*: After adding some cribellar silk over the cocoon surface, the mother cuts all the remaining supporting threads

of the platform in about 10 minutes around the cocoon. The cocoon becomes free from the platform and the spider then removes the cocoon that may be covered with additional sticky cribellar silk before it is carried to the nest.

10. *Transportation*: This is the last phase of the cocoon spinning behaviour. The cocoon after it is completely free, is carried by the mother within 1 to 3 minutes towards her nest. The method of transportation of the cocoon is different from the method used in transport of prey. The prey is practically dragged by several spiders towards the nest, but the cocoon is held by the palps and one or two anterior legs (Fig. 7), and is carried by the female into the brood chamber of her nest. The mother remains with the cocoon and she is often observed adding more cribellar silk on the surface of the cocoon. At times, she takes the cocoon out through a nest exit and exposes it to the rays of the sun. This behaviour has also been reported by Millot & Bourgin (1942) in *S. lineatus*, who believe that it is necessary for receiving the warmth from the sun.

The duration of different stages of cocoon construction is given in table 1. Each cocoon mesaures 6 to 8 mm in diameter.

The different silk glands involved in the construction of the cocoon in this social spider has been described in detail by Bradoo & Majupuria (1973). In addition to cribellar silk, produced by different glands, at least two types of silk glands, namely, cylindrical glands and tubular glands are involved in cocoon construction. These two kinds of glands are characteristic of females only.

TABLE 1

DURATION IN MINUTES OF TEN STAGES IN COCOON SPINNING BEHAVIOUR OF *S. sarasinorum* KARSCH

Stages	Dates of observation						
	Jan. 21	Feb. 8	15th	16th	25th	Mar. 5th	9th
Platform	11	13	12	15	14	9	13
Receiving valve	31	40	29	30	35	32	25
Rest	5	5	5	5	5	4	5
Oviposition	2	3	2	2	3	2	2
Concealing	5	7	5	5	6	4	5
Covering valve	40	50	46	43	41	48	45
Removal of supporting threads	2	3	5	2	2	3	2
Cribellar silk	45	37	46	35	40	49	45
Separation	6	4	5	7	9	7	9
Transportation	1	2	1	2	2	3	1
Total duration	148	164	156	146	157	161	152

Fecundity

Each female *S. sarasinorum* makes a total of 2 to 4 cocoons during her lifetime. The total number of eggs contained in a cocoon varies from 60 to 115, as found in 41 cocoons opened in the laboratory (Table 2). The average number of eggs deposited in each cocoon varies from 67 to 93. The total number of eggs deposited by a single female in her life time varies from 164 to 280. Millot & Bourgin (1942) found that each cocoon of *S. lineatus* contained 150 to 250 eggs. The immature individuals of *S. sarasinorum* that attain maturity late, deposit only few eggs and generally make a single cocoon. A female of this species made a cocoon on 18th January, 1965 in the laboratory, that contained 122 eggs and when this spider was shortly dissected in the laboratory, its ovaries contained 65 more eggs in different sizes within the two ovaries.

Table 2

Number of eggs in 41 cocoons of *S. sarasinorum* Karsch, in 1965

S. No.	Date	No. of Cocoons	No. of Eggs	Average No.
1.	29th Jan.	4	71-115	67
2.	9th Feb.	4	62-115	82
3.	25th Feb.	6	60-114	84
4.	26th Feb.	4	73- 95	87
5.	2nd Mar.	9	77-105	88
6.	10th Mar.	10	66-111	93
7.	23rd Mar.	4	61- 98	83
	Total	41	60-115	67-93

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